

NO. 5. ASTROLABE MADE BY IBRAHIM IBN SAID ASSOHLI, A.D. 1067-8,
WITH SIX PLATES FOR TWENTY-EIGHT STARS. FRONT VIEW.

SOME EUROPEAN AND ORIENTAL ASTROLABES.¹

By LEWIS EVANS, F.S.A. F.R.A.S.

The word "astrolabe" is derived from the Greek *ἄστρον*, a star, and *λαμβάνειν*, to take, meaning a star-taker or star-finder: it originally had a wide application extending to any instrument for showing or finding the position of the stars, so that it probably embraced star maps, celestial globes and armillary spheres, as well as those planispheric astrolabes, or projections of the sphere on a disc-shaped instrument, to which the word astrolabe has been more especially applied for the last thousand years.

The invention of the astrolabe is usually ascribed to Hipparchus, 150 B.C. or to Claudius Ptolemy, A.D. 130, but in 1899 Dr. M. F. Nau published in the *Journal Asiatique*, Paris, a Syriac manuscript, dated 956, which was a copy of a manuscript written about the middle of the seventh century by Severus Sabokt of Nisibe. This writer, who gained his knowledge from Greek sources, shows that the astrolabe was invented before the time of Ptolemy. Assuming this to be the case Dr. Nau demonstrates the great probability that the *arachnen* or spider's web, mentioned by Vitruvius (book ix) amongst sundials, was an astrolabe; and Vitruvius, writing in the first century, tells us that the invention of the *arachnen* (or astrolabe) was by some ascribed to Eudoxus of Cnidos c. 360 B.C. and by others to Appolonius of Perga, c. 240 B.C. But as Eudoxus, Appolonius, Hipparchus, and Ptolemy all studied mathematics in Egypt, it remains uncertain whether their knowledge was gained from earlier "wise men from the East" or whether one of them originally devised the instrument.

Whatever may have been the early history of the astrolabe, there is no doubt that our knowledge of it

¹ Read before the Institute, 6th July, 1910.

is derived from the Arabs, and more especially through the writings of Messahala or Macha-Allah, an Arabian mathematician who was by religion a Jew, and who, in the latter part of the eighth century wrote a treatise on the astrolabe of which several transcripts in Arabic, Latin, and other languages still exist. Indeed the treatise on the astrolabe written by Geoffrey Chaucer, probably in 1391, for the use of his son "Litell Lowys," to whom he had given a "suffisaunt astrolabie" was undoubtedly based on a Latin version of Messahala's treatise.

There still exist something like two hundred early manuscripts on the astrolabe, and at least a hundred books and papers have been written about it.¹

The earlier writers, the last of whom wrote in 1712, treat the astrolabe as the chief amongst astronomical instruments; but it ceased to be used in Europe shortly after the introduction of the reflecting quadrant, named after Hadley, but invented simultaneously in this country and America about 1730, by Sir Isaac Newton and Thomas Godfrey, a glazier and mathematician in Philadelphia. The astrolabe continued to be in fairly general use in the East until some fifty years ago, and may even now be sometimes seen.

An amusing account of the use of the astrolabe is given in the one hundred and sixty-first night of the Arabian Nights.²

A young tailor having fallen in love with the daughter of the kadee of Bagdad, and wishing to make a good impression in a great

¹ Of these latter the more important are:

J. Stofferinus (J. Stoeffler): *Elucidatio fabricae ususque astrolabii nuper ingeniose concinnata atque in lucem edita*: fol. Oppenheim, 1512, 1513, 1524; fol. Tubingae, 1534; fol. Moguntiae, 1535; 8vo. Lutetiae, 1553, 1585, etc.

Dominique Jacquinet: *L'usage de l'Astrolabe*; 4to Paris, 1545, 1558, 1559, etc.

J. Focard: *Parapbrase de l'Astrolabe, contenant les principes de geometrie, la sphere, l'astrolabe, le miroir du monde*; 8vo. Lyon, 1546, 1555.

John Blagrove: *The Mathematical Jewel*, Lond. 1585.

F. Ritter: *Astrolabium das ist, etc*; 4to. 2 vols. Nurnberg, 1599, 1613, 1650; folio 1, vol. Nurnberg, 1640.

And of more modern writers,

W. H. Morley: *Description of a planispheric astrolabe constructed for Shab Sultan Husain Safawi, etc. and twelve other astrolabes, Eastern and European*; large folio, London, 1856, 21 plates.

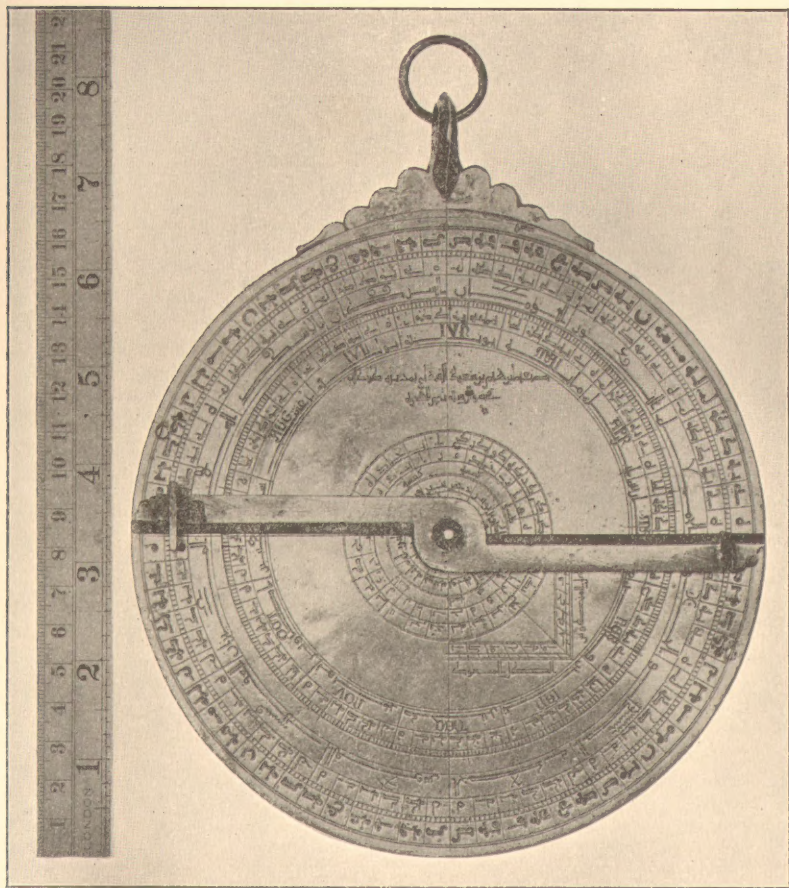
Rev. Walter W. Skeat: *A treatise on the astrolabe addressed to his son Lowys by Geoffrey Chaucer, A.D. 1391*; 8vo, London, 1872, Chaucer Society.

Almerico da Schio: *Di due astrolabi in caratteri cufici occidentali trovati in Valdagno*; 4to, Venezia, 1880.

Margaret L. Huggins: A paper in *Astronomy and Astro-Physics*, no. 130.

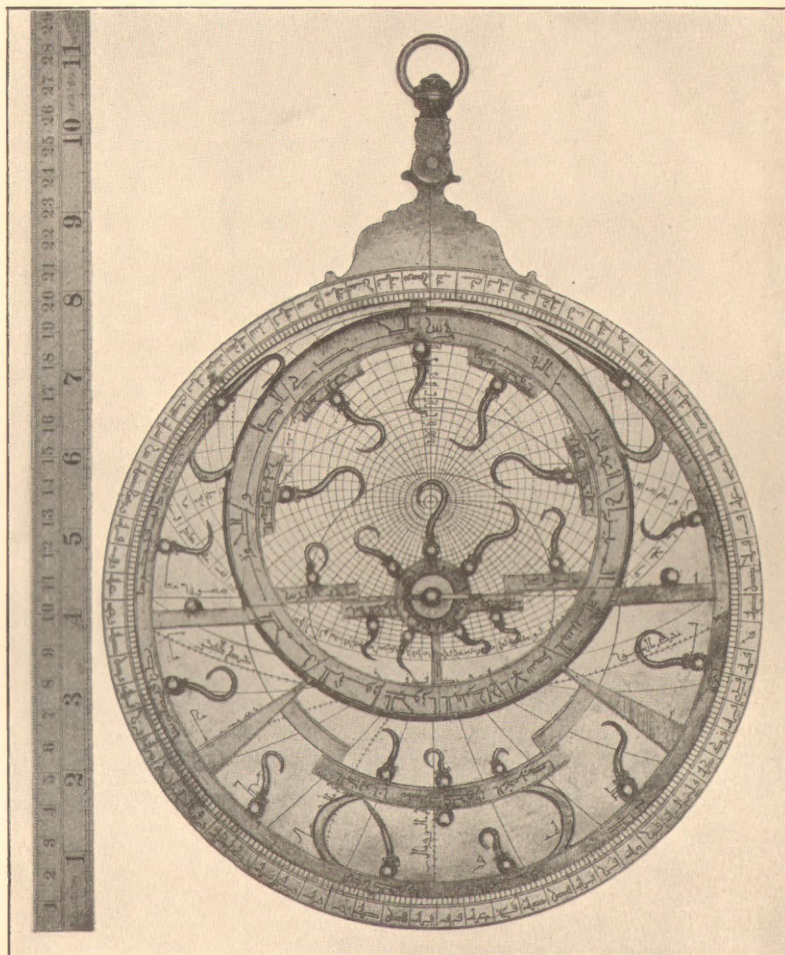
Besides various papers by Woepke, Dorn, Amari, Ionides, the works of Sédillot, father and son, and others.

² Lane, i, 331, 332.



NO. 5. ASTROLABE MADE BY IBRAHIM IBN SAID ASSOHLI, A.D. 1067-8,
WITH SIX PLATES FOR TWENTY-EIGHT STARS. BACK VIEW.





NO. 18. ASTROLABE DATED 1494-5, WITH CUFIC CHARACTERS. FRONT VIEW.

hurry, called in a barber to shave him, who, after much wearisome talk, took out a handkerchief and opened it; and lo! there was in it an astrolabe consisting of seven plates; and he took it and went into the middle of the court, where he raised his head toward the sun and looked for a considerable time; after which he said: "Know that there have passed of this our day, which is Friday, and which is the tenth of Safar, of the year 263 of the flight of the prophet, upon whom be the most excellent of blessings and peace, and the ascendant star of which, according to the required rules of the science of computation, is the planet Mars, seven degrees and six minutes; and it happeneth that Mercury hath come in conjunction with that planet, and this indicateth that the shaving of the hair is now a most excellent operation."

The principal part of planispheric astrolabes is a circular plate, usually of brass, varying in thickness from $\frac{1}{8}$ to $\frac{1}{2}$ inch, and in diameter from 2 inches to about 30 inches. In use this plate is suspended from the left thumb by a ring, which is so attached to a projection on the plate as to leave it free to assume a perpendicular position. The back of the instrument is flat, and has on it various concentric circular scales. The outer one is divided into 360 degrees, the next into the signs of the zodiac, and the third into the months of the year; this last circle is usually drawn somewhat eccentric from the instrument. Within these is often found the old geometrical square of *umbra recta* and *umbra versa*, used for taking altitudes, above which there may be a scale of planetary hours; and sometimes, especially in oriental astrolabes, a scale of astronomical hours, and a sinical quadrant; on the back revolves the alidade or rule, *izadah* in Arabic, an index arm with sights at each end, used for taking altitudes.

The front of the astrolabe is in most cases slightly recessed in the middle, leaving a fairly wide margin at the edge. Round the margin is drawn a scale of degrees, usually divided into quadrants, numbered from the horizontal diameter of the instrument. Within the central hollow or recess are placed circular plates, or "tables," in Arabic *safibah*, on which are drawn projections of the sphere showing circles of almicanter, and azimuths for various latitudes. A few astrolabes, which are known as plain astrolabes, have no central recess, but have the projection suitable for some one latitude drawn on the

main plate ; but as a rule there are from one to eleven plates, stored away in the *mater* or body of the instrument, *umm* in Arabic. These plates are covered by the *rete*, or *ankabut*, a pierced plate on which the makers usually expended a great deal of time and trouble. On it is always shown an eccentric circular band representing the ecliptic, and on the network about this are arranged from four to sixty or more pointers or tongues, according to the size and quality of the instrument. Each of these pointers represents a star, the name of which is usually appended to it.

The plates and *rete* are held in position by means of a pin, *kutb* in Arabic, passing through the centre of the instrument, and having a small wedge, or *faras*, which transfixes it in front of the *rete*.

The projecting piece to which the suspension ring is attached, called by the Arabs the *kursi* or throne, is very conspicuous in oriental astrolabes, especially in the more modern Asiatic ones, as will be seen by comparing plate v with the earlier astrolabes of plates i to iv, and the later plates showing European instruments.

The quality of astrolabes was usually estimated by the number of circles shown.

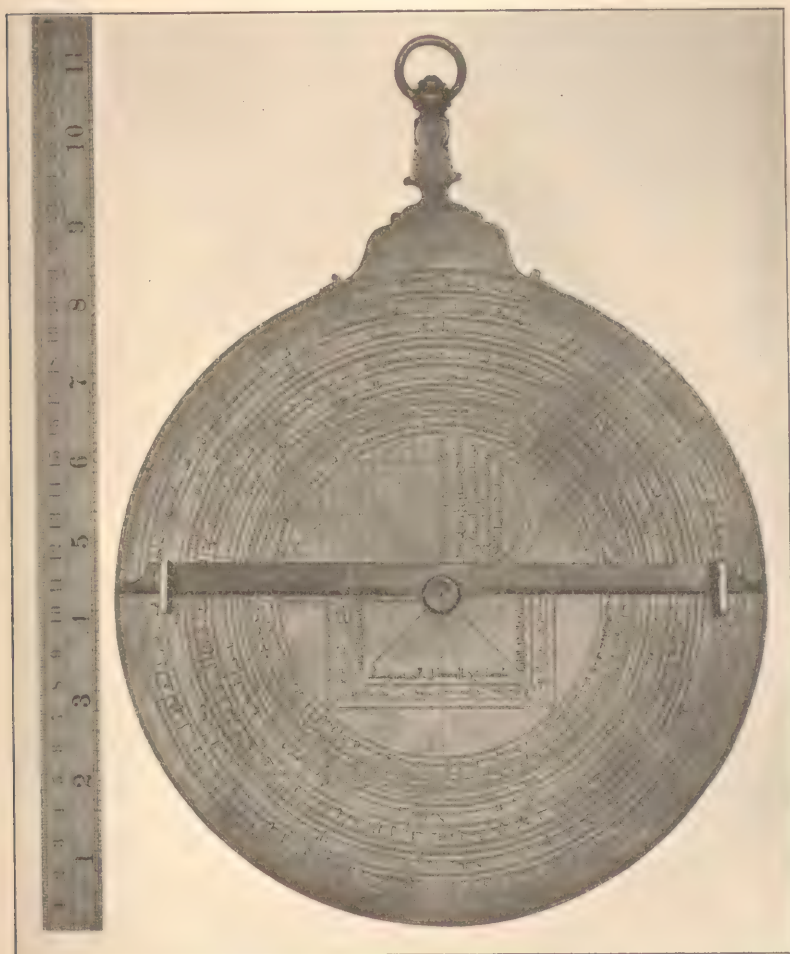
A *Tamm*, or perfect astrolabe, had 90 circles or one for each degree. Nos. 15 and 16 are *Tamm*. *Nisfi*, or bipartite, had one circle for each two degrees, as in no. 20, plate v. *Thulhi*, or tripartite, one for each three degrees ; as no. 19 (plate iii). *Khumsi*, or quinquepartite, one for each five degrees ; as no. 5 (plate i). *Sudsi*, or sexpartite, one for each six degrees.

Of the uses of the astrolabe I have purposely said very little. Even as early as the seventh century Severus Sabokt mentioned the following :¹

1. To find the hour by day, the degree in which the sun rises and sets, and also the meridian.
2. To find the hour at night.
3. To find the hour at night by the moon.
4. To find in what sign and degree the sun is.
5. To find in what sign and degree the moon and the planets are.

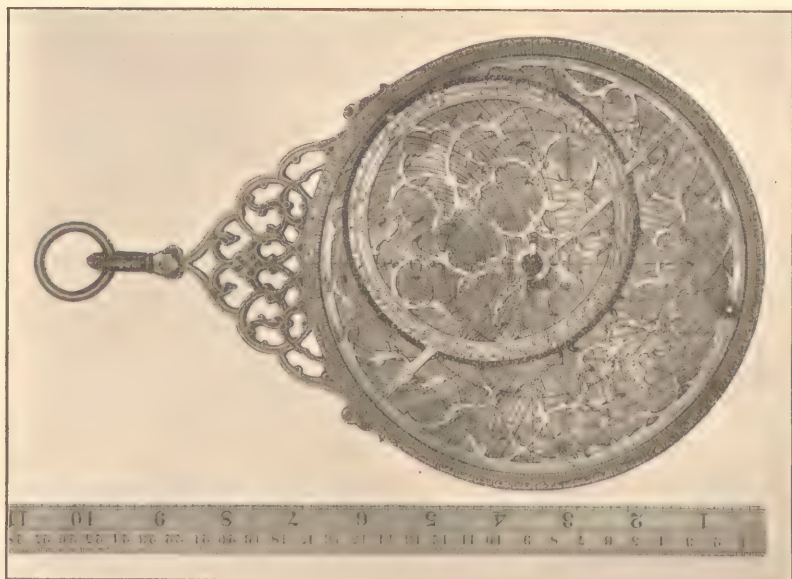
¹ Those wishing for further information as to uses of the astrolabe should consult the Rev. W. W. Skeat's edition of

Chaucer's treatise on the Astrolabe, Chaucer Society, 1872.

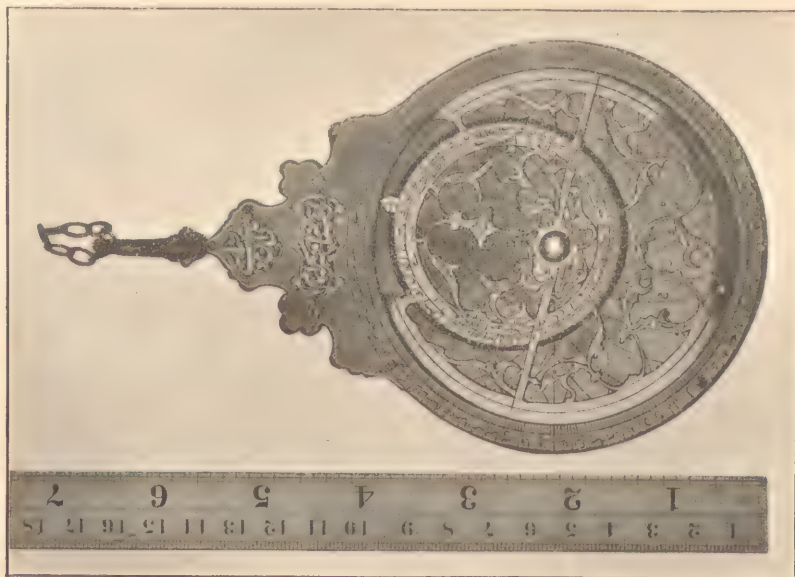


NO. 18. ASTROLABE DATED 1494-5, WITH CUFIC CHARACTERS. BACK VIEW.





NO. 20. ORIENTAL ASTROLABE DATED 1644.



NO. 19. PERSIAN ASTROLABE DATED 1641.

6. To find the latitude of the moon.
7. To see if the astrolabe is accurately made.
8. To see if the index or rule is accurately made.
- 9 to 12. More or less astrological.
13. To find which of two towns is the more northerly or southerly.
14. To compare the longitude of two towns.
15. To compare the meridians of two towns.
16. To find the right ascensions according to Ptolemy.
17. To find by the stars or the sun in what "climate" one is.
18. To find the latitudes of the 7 climates.
19. To know the longitude and latitude of the fixed stars.
- 20 and 21. Missing.
22. To find the declination (?) of each sign of the zodiac.
23. To find the declination N. or S. of the sun in each sign and degree.
- 24 and 25 relate to climates.

The following list shews the age and the makers of the earliest astrolabes known :

ORIENTAL ASTROLABES.

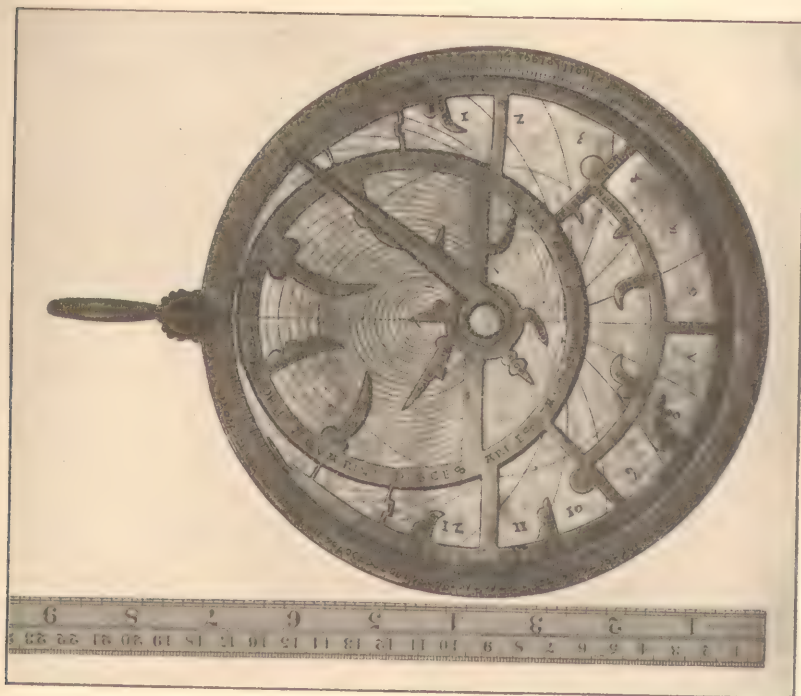
- No. 1. In the Bibliothèque Nationale Paris : $5\frac{5}{8}$ inches diameter, 4 plates for 47 stars : "made by Ahmed-ben-Khalaf for Djarfar, son of Moktafi Billah," who was born A.D. 916, and died 987 : not dated, but about A.D. 950. There is in the National Museum, Palermo, the *mater* of an astrolabe inscribed "made by Hamed-ben-Ali, A.H. 348 or 343," i.e. A.D. 964 or 969,¹ but Americo da Schio says this is a twelfth- or thirteenth-century copy of the early original.
- No. 2. In the Istituto degli Studi Superiori, Florence : $6\frac{1}{4}$ inches diameter : unfinished :

¹ Mohammedan chronology dates from the Hegira or prophet's flight, which took place A.D. 622.

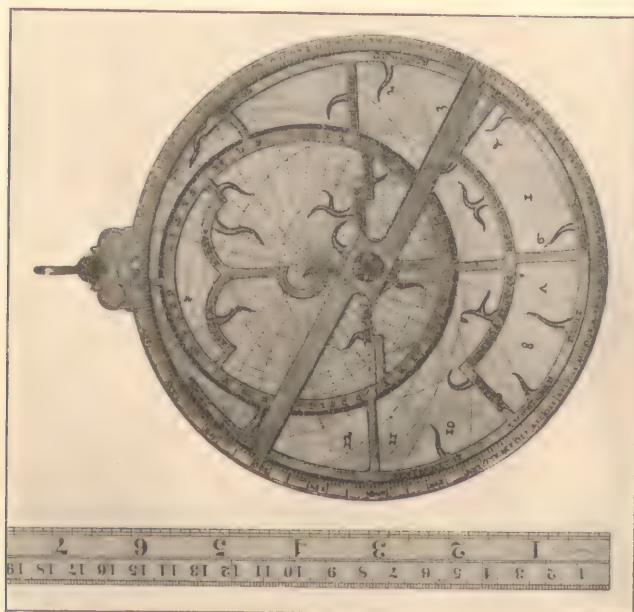
- made under pope Silvester II : undated, but about A.D. 998.
- No. 3. In the Royal Library, Berlin : 9 plates for 29 stars : inscribed "made by Mohammed-ben-al-Saal in the city of Toledo, A.H. 420." A.D. 1029.
- No. 4. In the Archaeological Museum, Madrid : $9\frac{1}{2}$ inches diameter : 5 plates for 26 stars : made by Ibrahim ibn Said el Muazina Assohli in Toledo, A.H. 459.¹ A.D. 1066-7.
- No. 5. In my collection : by the same maker as no. 4 : 6 inches diameter : 6 plates for 28 stars "made by Ibrahim ibn Said Assohli in the city of Toledo in Schawwal of A.H. 460." A.D. 1067-8 (plates I and II).
- No. 6. Belonging to Prince D. Tomaso Corsini : 5 inches diameter : A.H. 496. A.D. 1118.
- No. 7. In the Museo Kircheriano, Rome : $9\frac{3}{8}$ inches diameter, 10 plates : made by Ibrahim ibn Said in Valenza. A.H. 593. A.D. 1197.
- No. 8. One described by F. Sarus, belonged to Baron Larrey : $6\frac{1}{2}$ inches diameter : 4 plates for 20 stars : "made by Abou-Becker ibn Joseph in Morocco." A.H. 605. A.D. 1208.

The five following were all made by the same hand :

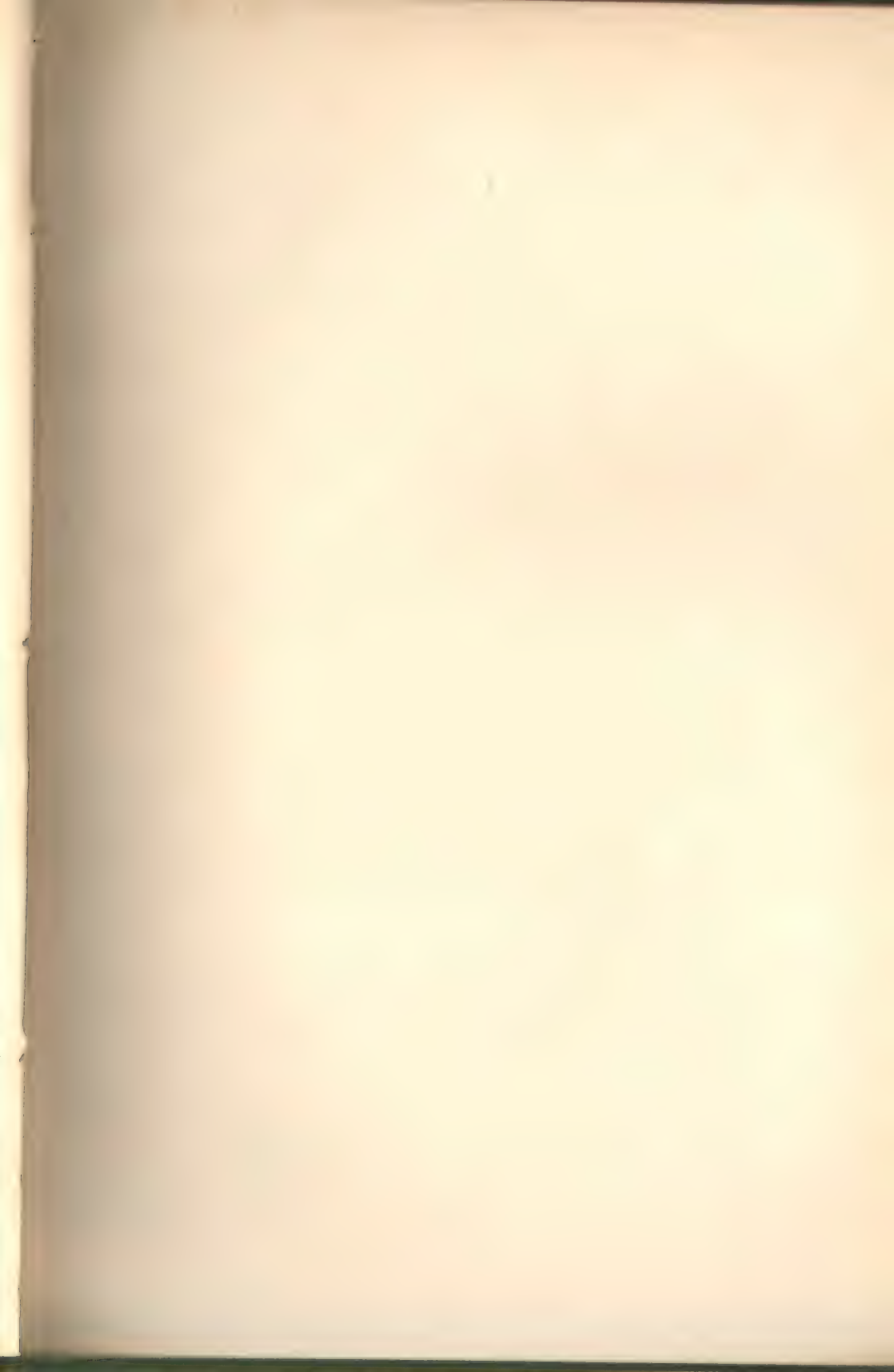
- No. 9. Belonged in 1893 to M. M. H. Sauvaire : $6\frac{1}{2}$ inches diameter (the *mater* only) : made by Mohammed ben Foutouh al-Khemairi in the city of Seville. A.H. 609. A.D. 1212.
- No. 10. A special universal astrolabe of the form invented in the second half of the eleventh century by Abuiz-hac-Azarquiél and usually called Arzachel. $8\frac{3}{8}$ inches diameter for 38 stars : made at Seville by the same maker. A.H. 613. A.D. 1216.
- No. 11. Another Arzachel in the Bibliothèque Nationale, Paris : $8\frac{7}{8}$ inches diameter for 32 stars : the same maker and place, A.H. 615. A.D. 1218.

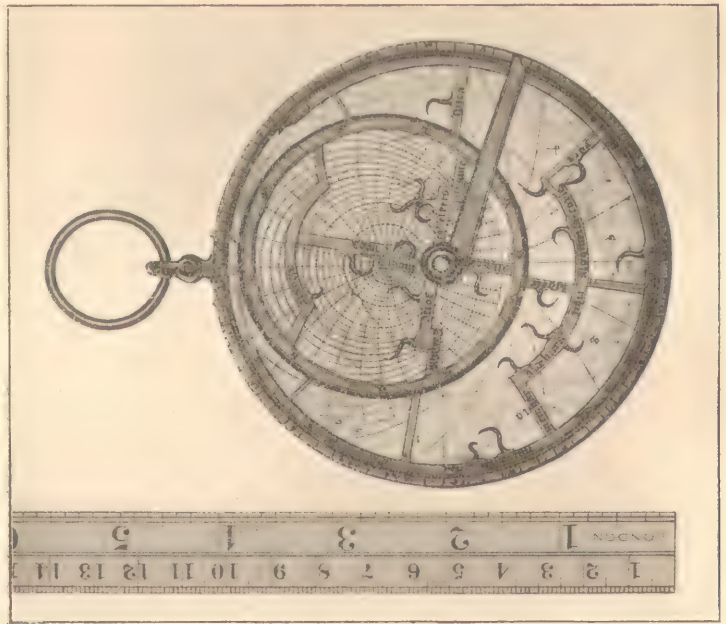
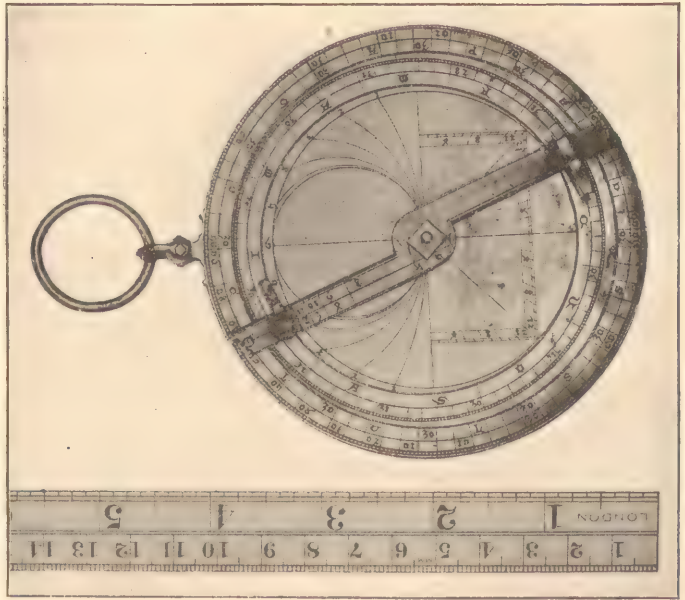


NO. 22. ITALIAN ASTROLABE OF ABOUT 1400.



NO. 21. ITALIAN ASTROLABE OF ABOUT 1400.





- No. 12. Another Arzachel, which belonged to Baron Larrey : $8\frac{3}{4}$ inches diameter : the same maker, place, and date.
- No. 13. An astrolabe in my collection : $7\frac{7}{8}$ inches diameter, with 4 plates for 29 stars : the same place and maker, A.H. 618. A.D. 1221.
- No. 14. One belonging to Mr. E. B. Knobel, F.R.A.S. $7\frac{3}{8}$ inches diameter, with 5 plates, for 29 stars : the same place and maker. A.H. 621. A.D. 1224.
- No. 15. A Syriac astrolabe inlaid with gold and silver which was exhibited in the Paris Exposition of 1900, and is now in my collection : 11 inches diameter, with 3 plates, probably for about 30 stars, but the *rete* which was made in the fifteenth century is imperfect : made for Al-Malik al-Ashraf Moudaffar-ed-din, shah of Armenia (a nephew of the sultan Saladin), by "Abd-al-Karim, al-Misri al-Usturlabi" (the Egyptian, the astrolabe maker). A.H. 625. A.D. 1227.
- No. 16. A similar astrolabe, also inlaid with silver and gold and with its original *rete*, in the British Museum : 13 inches diameter, with 3 plates : made for Al-Malik al-Ashraf, sultan of Damascus, by Abd-al-Karim, al-Misri al-Usturlabi. A.H. 633. A.D. 1235.

In the British Museum there are 33 astrolabes, including 5 English ones ; the earliest English specimen has plates for Paris, Oxford, Montpellier, Rome, Jerusalem and Babylon, and is dated 1326. Perhaps the most beautiful one in the museum is a Persian one made for Shah Husein Safawi, king of Persia, by Abd-al-Ali in 1712. It has 8 plates and 63 stars on its *rete* : its diameter is $12\frac{5}{8}$ inches.

As it would be impossible to describe adequately in this short paper the very interesting astrolabes in the British Museum, it is proposed to give a short account of some astrolabes in my possession, taking them approximately in chronological order, but mentioning the oriental astrolabes first. The earliest in the chronological list, nos. 5, 13, and 15, have already been described.

- No. 17. $5\frac{1}{8}$ inches diameter, was made by "Ahmad son of Ali in Cairo," A.H. 681. A.D. 1282. It is not an ordinary astrolabe and probably never had a *rete* or plates: the scales on the upper half show sines, cosines, and almicanter, the scale in the western lower limb seems to be a scale of half tangents, the numerals are coptic.
- No. 18. $8\frac{1}{4}$ inches diameter, for 27 stars with 3 plates. "Its maker is the humble servant of his Lord, Muhammad the son of Ahmad-al-Batuti, God support him." A.H. 900. A.D. 1494-5; the inscription, in cufic characters, runs vertically inside a semicircular space on the back (plates III and IV).
- No. 19. A Persian astrolabe $4\frac{1}{2}$ inches in diameter, with 4 plates for 27 stars, inscribed "astrolabe made for Abd-ur-Razzak in the city of Mashhad," (Meshed in Khorasan), A.H. 1051. A.D. 1641. The instrument has been used as a hammer and its rim is much bruised, but round it appears to be written the maker's name, "Ibrahim son of Sharaf ud-din-Husain" (plate v).
- No. 20. An oriental astrolabe $6\frac{5}{8}$ inches diameter, 5 plates, for 38 or 40 stars. "The work of the humble servant of God, Mohammad Mekym ibn Tyse (the Christian), ibn al-Haddad (the locksmith), Asterlabi (astrolabe maker)": this is dated in two methods, A.H. 1053 and "In the year of Alexander (i.e. Seleucidae) 1955," each equal to A.D. 1644 (plate v).

EUROPEAN ASTROLABES.

- No. 21. An Italian astrolabe 6 inches in diameter, with 4 plates for 27 stars. On this instrument almost all the stars have their Arabic names, the *Kursi* is not large and the forms of the Arabic numerals with the early use of the more modern 8 are interesting, also the very clear Lombardic lettering (plate vi).



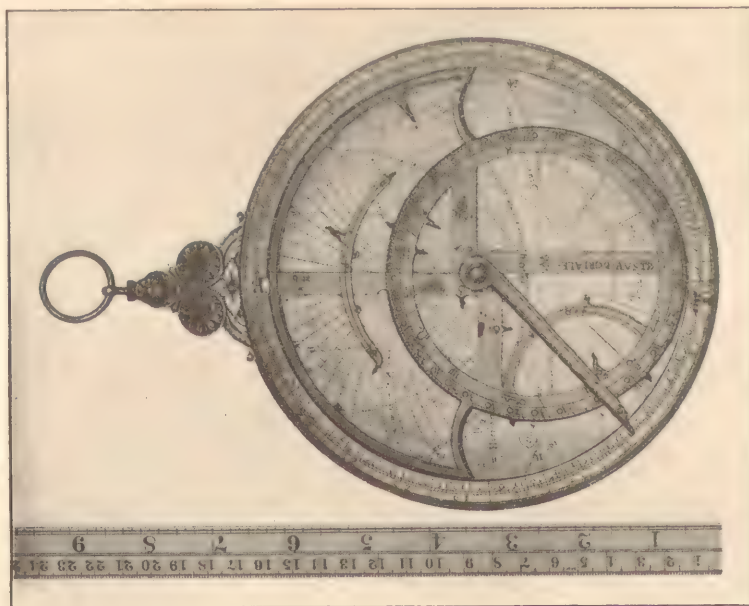
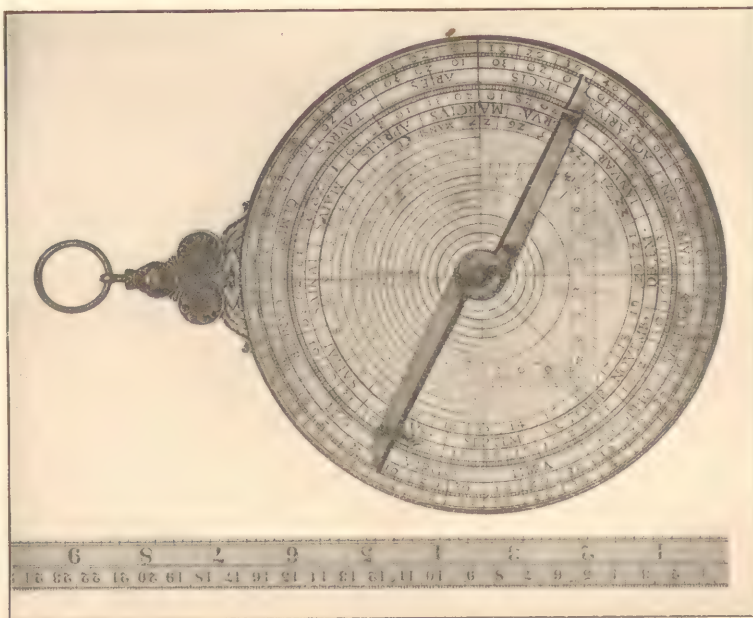
NO. 25. SMALL ITALIAN ASTROLABE OF ABOUT 1450.



NO. 24. SPANISH ASTROLABE OF ABOUT 1450 WITH MANY ARABIC NAMES.

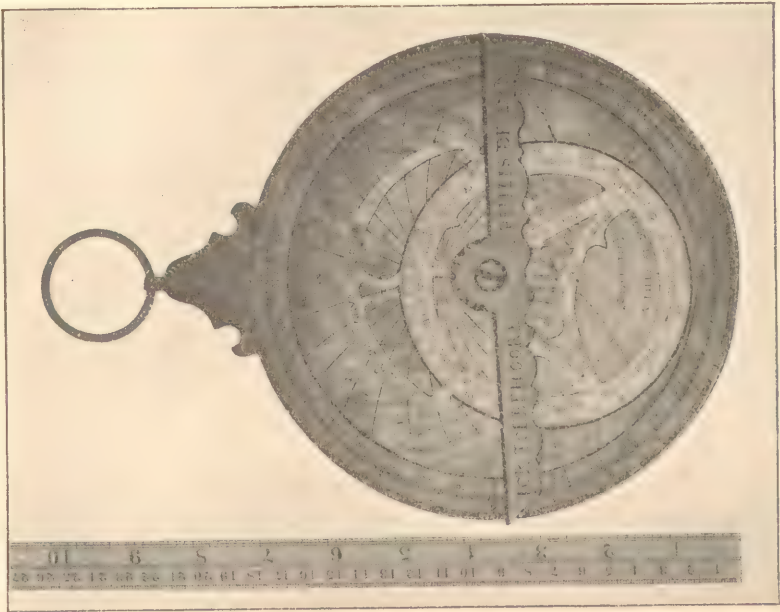




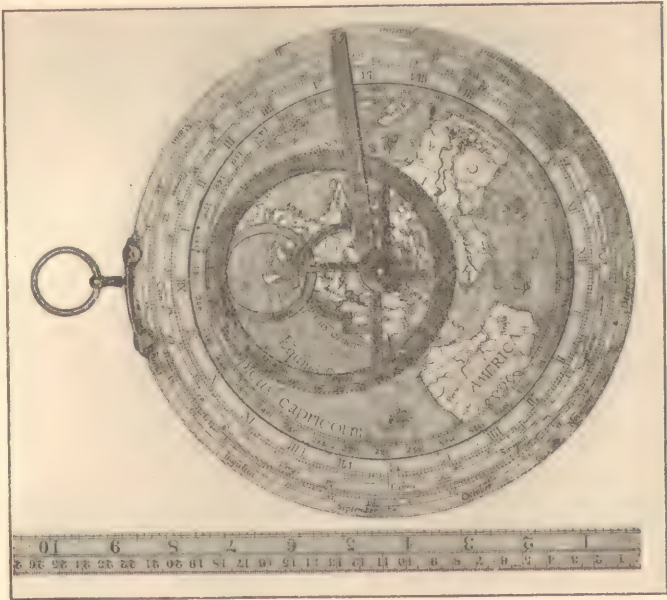


NO. 26. ITALIAN ASTROLABE, DATED 1521. THE BACK SHOWS THE PLANETARY SPHERES, AND A CIRCLE OF THE MOON'S MANSIONS.





NO. 29. FRENCH ASTROLABE DATED 1595.



NO. 28. GEOGRAPHICAL ASTROLABE MADE AT ANTWERP, 1560.

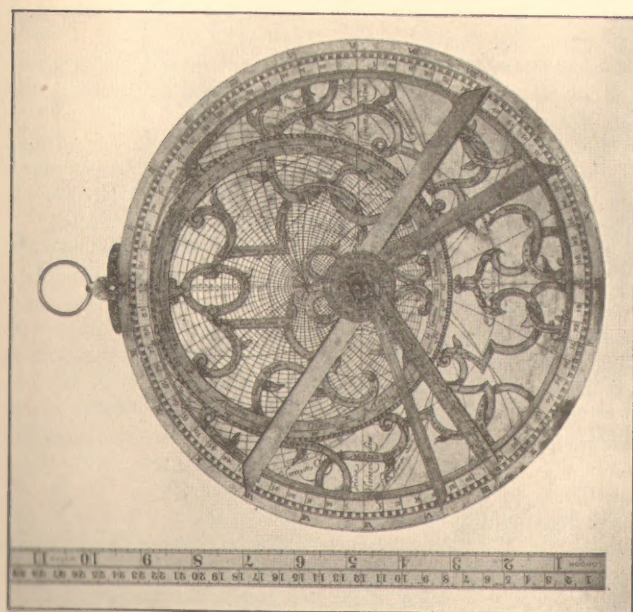
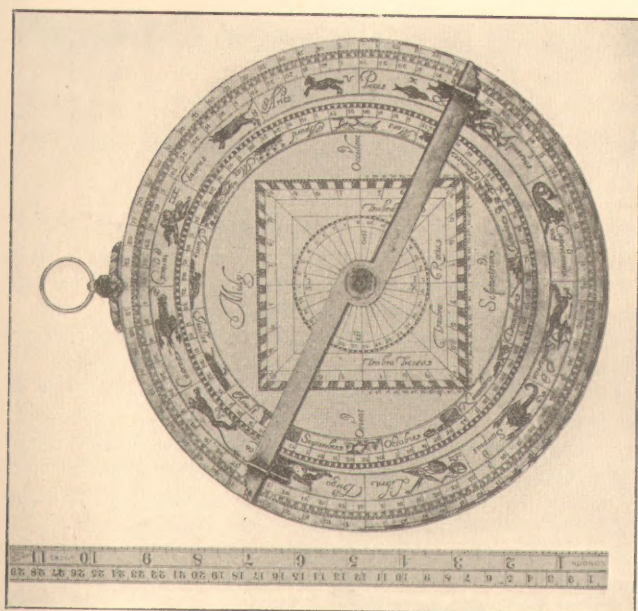
- No. 22. Probably Italian, $7\frac{1}{8}$ inches in diameter, with 5 copper plates for climates, not latitudes, 18 stars, only 3 or 4 stars with Latin names, about 1400. The back has been partly erased for some alteration or correction (plate vi).
- No. 23. French astrolabe 4 inches in diameter, with 5 plates for 21 stars, about 1400, with gothic lettering and early numerals; the back shows clearly the usual circles and scales of the astrolabes "back" (plate vii).
- No. 24. Spanish astrolabe $11\frac{1}{8}$ inches in diameter, a plain astrolabe, that is to say with no loose plates, for 37 stars, c. 1450; more than half the stars have Arabic names. This is a *Tamm* or perfect astrolabe with 90 almacanfers. The *kursi* is extremely small (plate viii).
- No. 25. An Italian astrolabe, formerly gilt, plain, for 4 unnamed stars, $2\frac{3}{8}$ inches in diameter. I think this is the smallest astrolabe that I have seen (the largest is in the Mainz museum and is about 2 feet 8 inches in diameter). The stars on this are Aldebaran; Regulus; Alhave; Altair (plate viii).
- No. 26. Italian astrolabe $6\frac{3}{4}$ inches in diameter, with 3 plates for 21 stars. 1521. This has no names to any of the stars but nearly all have planetary signs to them; the back shows the planetary spheres and has an unusual circle of the moon's mansions (plate ix).
- No. 27. Astrolabe $4\frac{3}{4}$ inches in diameter, with 2 plates, the *rete* shows no star pointers, but is simply an ecliptic circle showing the pole star; probably there was once an arm revolving on the centre of the ecliptic circle, where there is now a hole marked "polus solis." The back shows a coat of arms, between the letters R R, "per Johannem Wagner. Norimburg MDXXXVIII." The hinged pinules on the rule are finely ornamented.
- No. 28. A geographical astrolabe $8\frac{1}{2}$ inches in diameter, with one plate. The *rete*, like that of Wagner's astrolabe, is limited by the ecliptic circle, but

this shows 8 stars within the ecliptic. The "label" is marked with north and south latitudes. On the back is an *analemma* (a meridional projection of the sphere) on a revolving plate; this side will show the hour, the time of sunrise and sunset and the duration of twilight. The instrument is inscribed "Aegidius Cuiniet antverpianus facie A° 1560."

No. 29. French astrolabe $7\frac{1}{4}$ inches in diameter, with 1 plate for Paris and Lille, 13 stars. On the alidade is "Ick toebehoore Philis de Din," and on the back round I.H.S. "Sit nomen Domini benedictum in secula seculorum, 1595" (plate x).

No. 30. A plain French astrolabe $9\frac{3}{8}$ inches in diameter for 39 stars, one double-ended alidade and 3 labels or indices on the front, besides the rule on the back. The figures for the signs of the zodiac, and the emblems of the months' work as well as the *rete*, resemble the work of P. Danfries, a French instrument maker of about 1590 (plate xi).

As I have already stated, there are thirty-three astrolabes in the British Museum, while I possess forty-one; and in all there must be a hundred in this country and probably over three hundred altogether in Europe; whilst hidden in the East there may still be a great number. So it is very possible that specimens may exist dating back far beyond 950, the earliest date ascribed to any now known to me.



NO. 30. FRENCH ASTROLABE OF ABOUT 1600 WITH THE SIGNS OF THE ZODIAC AND THE EMBLEMS OF THE MONTHS.

